Hello, I would like to take the next few minutes to up date you on the H- ion source group activities as of June 1, when I moved from Argonne to Fermilab.

Briefly, my back ground, is in Atomic physics and more recently at Argonne I worked on Electron Cyclotron Resonance Ion Source development for the production of highly charged positve ions.

Chuck Schmidt and Vadim Dudnicov as well as the technical staff here have made my introduction into the world of negative ions a productive one

And have played a large part in getting the H- test bench up and running again.

In the last few months, my primary focus has been on familiarizing my self with the H- test bench and the LINAC control systems as well as studying the parameter space of H- ion sources. Part of this effort was in writing shell scrips for AC-Get-Data, and thanks to the help of Elliott McRorry, I was able to use this software to collect some of the data I'll be showing you today.

As you know, the two things we would like achieve are to

increase the H- current out of the ion source such that the LINAC current goes up by about 45% and secondly,

to decrease the emittance at the source in order to further increase the effective brightness.

Two slides
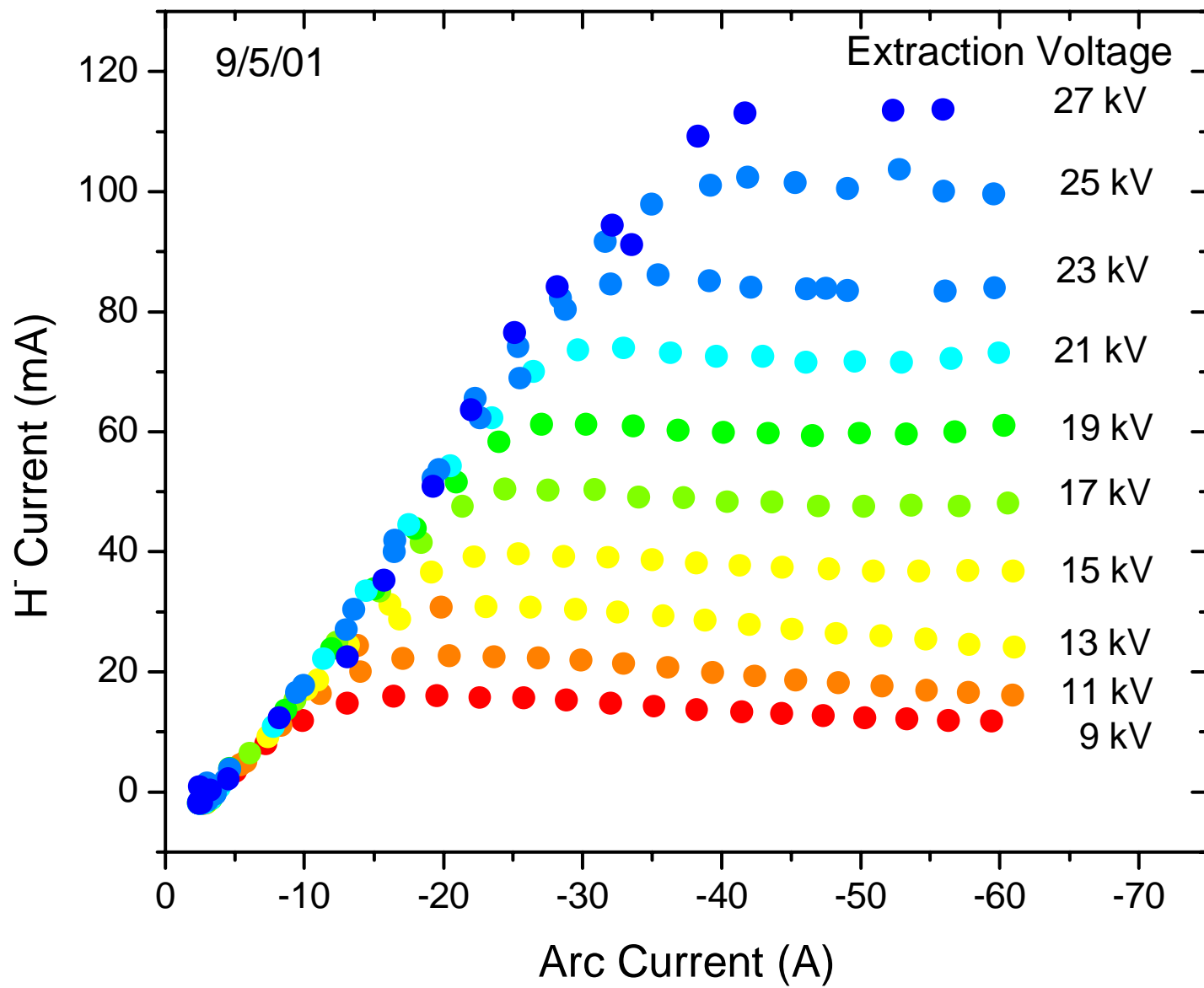
Schematics of LEBT and

Ion Source

LINAC Performance
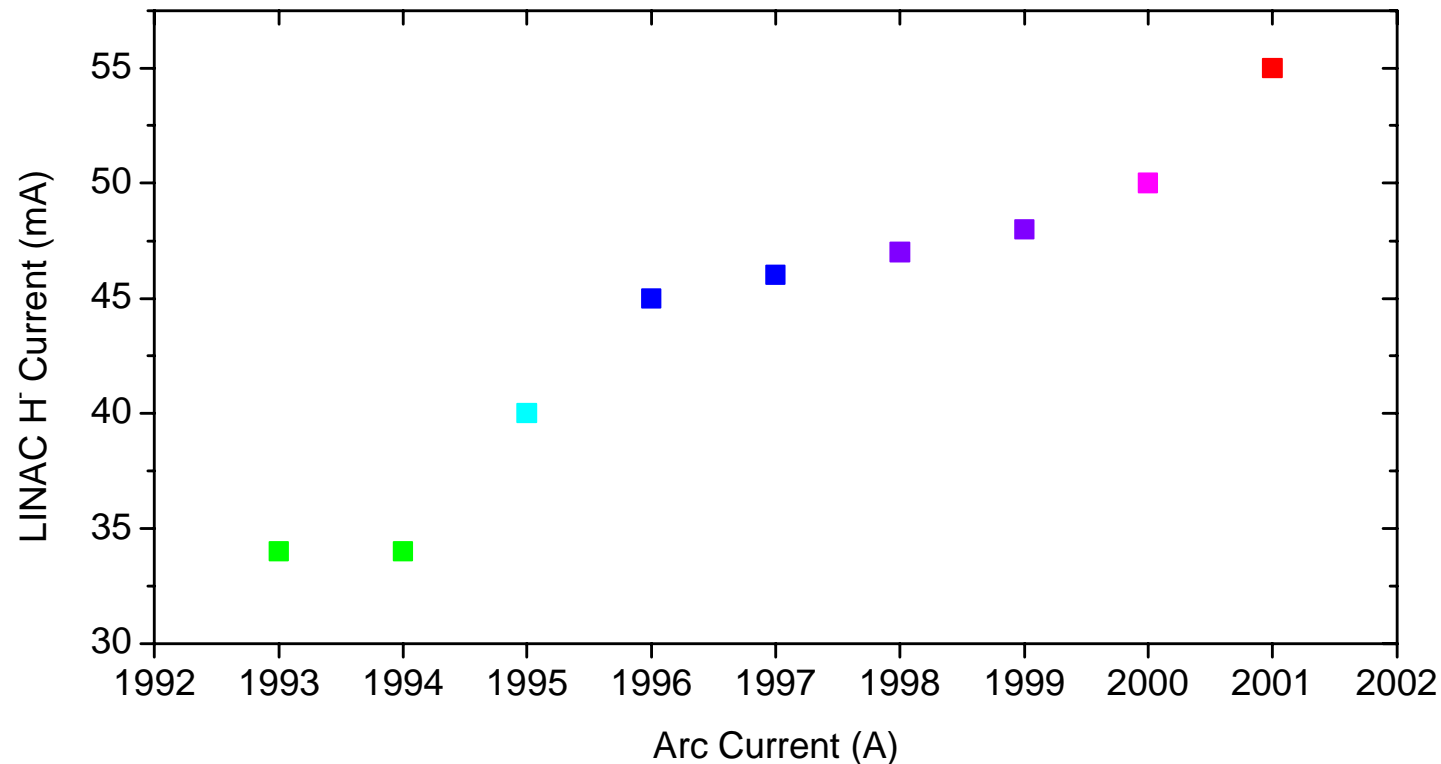
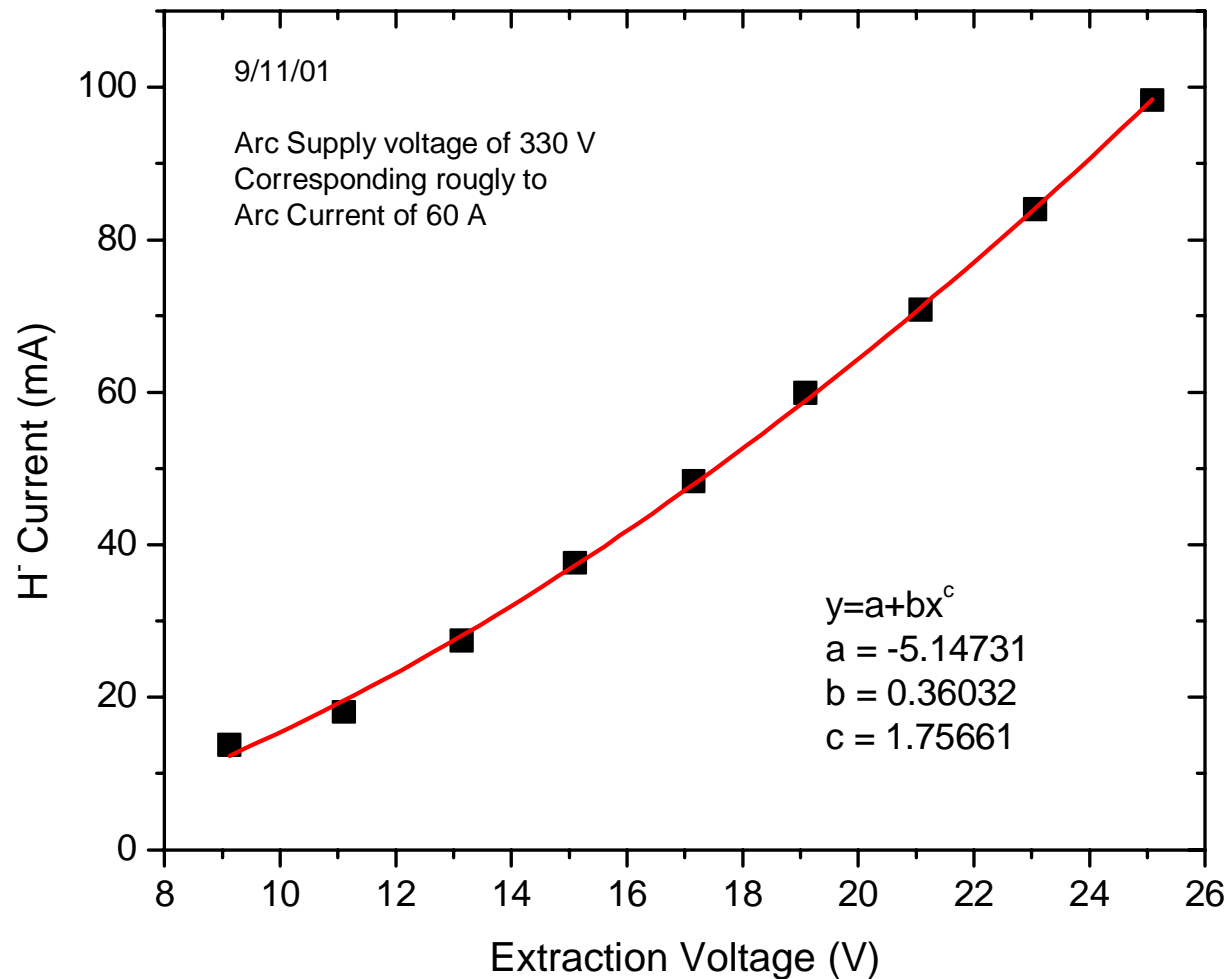Y 2K: 47 mA   30 µs 8.5×10^{12} protons/pulse

Today: 55 mA   30 µs 1.0×10^{13} protons/pulse

Requires 79 mA from the Preac. (30% loss)

Stable Capacity: 80 mA   90 µs 4.5×10^{13} protons/pulse
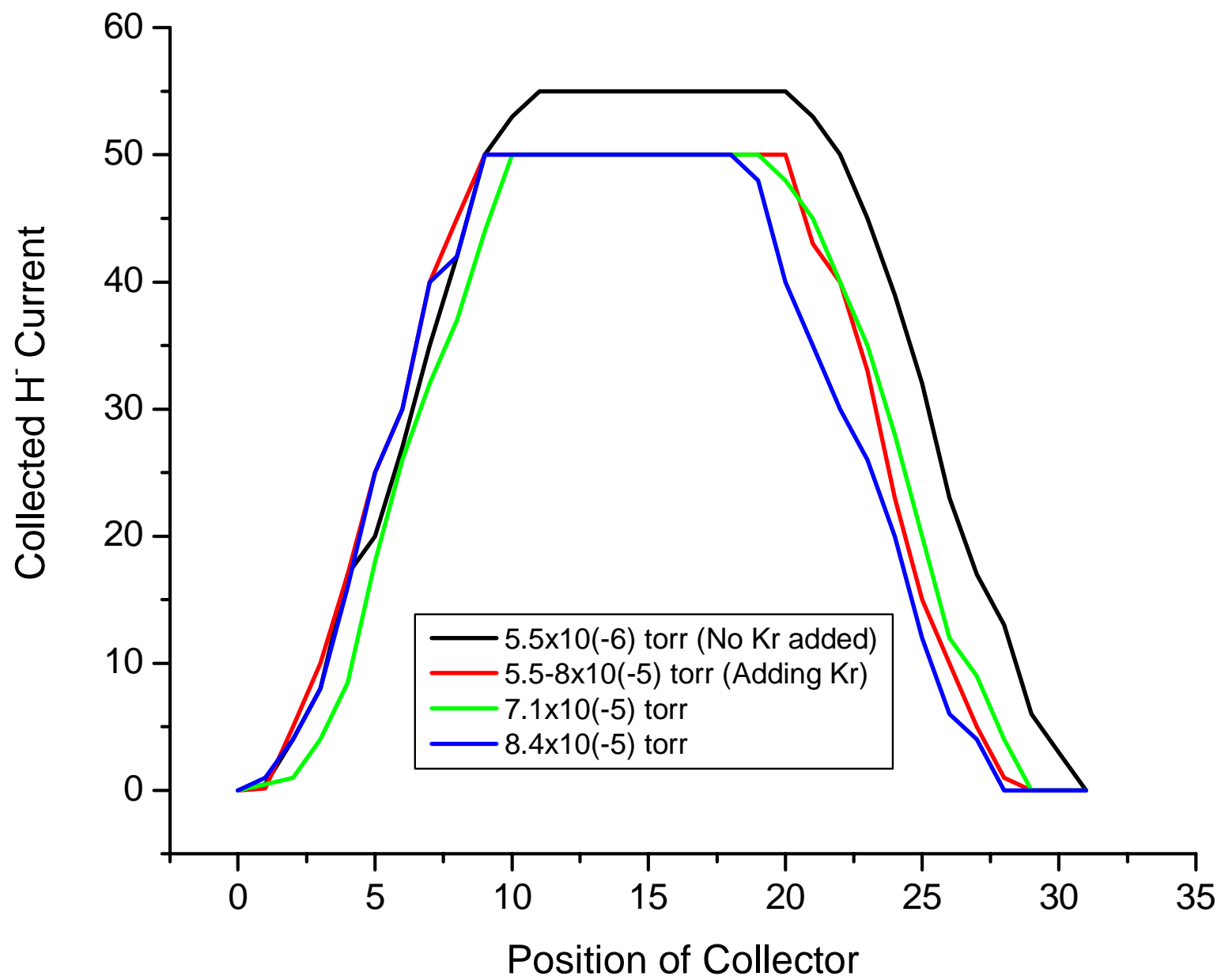
Requires 114 mA from the Preac.

Preacc emittance aprox.1.3 mm-mrad (normalized 95%).
Possible??   0.5 mm-mrad (normalized 90%).

Data showing 1% increase in beam intensity

When Kr is added.

Collected H⁻ Current vs. Position of Collector

- 5.5x10(-6) torr (No Kr added)
- 5.5-8x10(-5) torr (Adding Kr)
- 7.1x10(-5) torr
- 8.4x10(-5) torr

Areas for further research

Increasing extraction voltage

Sparking/ beam interruptions
greater then 1% are unacceptable

Optimize the magnetic field
for the source

Changing the pole configuration
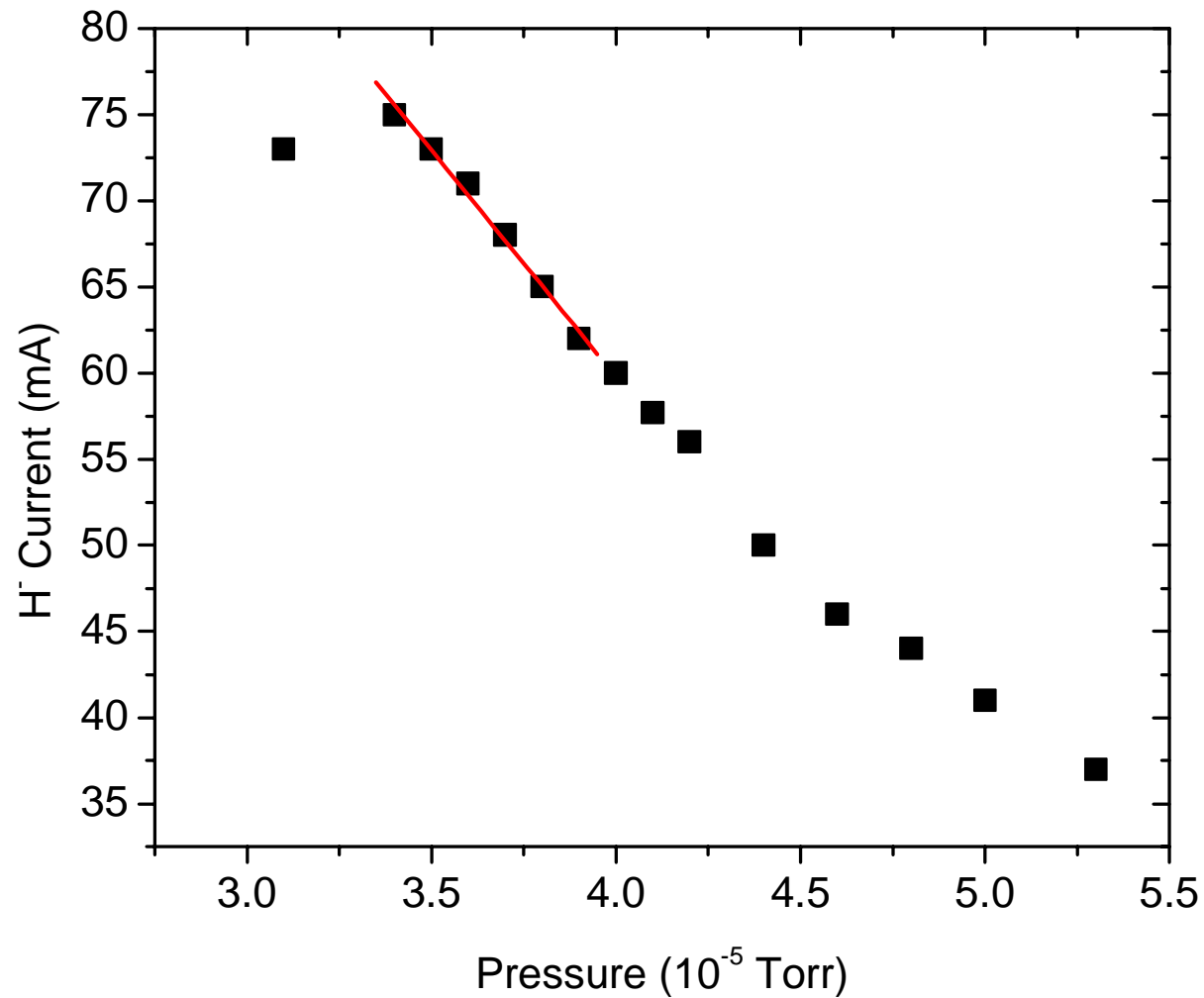is not possible on line

Improved extraction optics

Go to triode but space is limited

Space charge neutralization/
focusing

Emittance measurement
Current density measurements

Source longevity

Long test runs (1500 hrs currently)
Better cooling

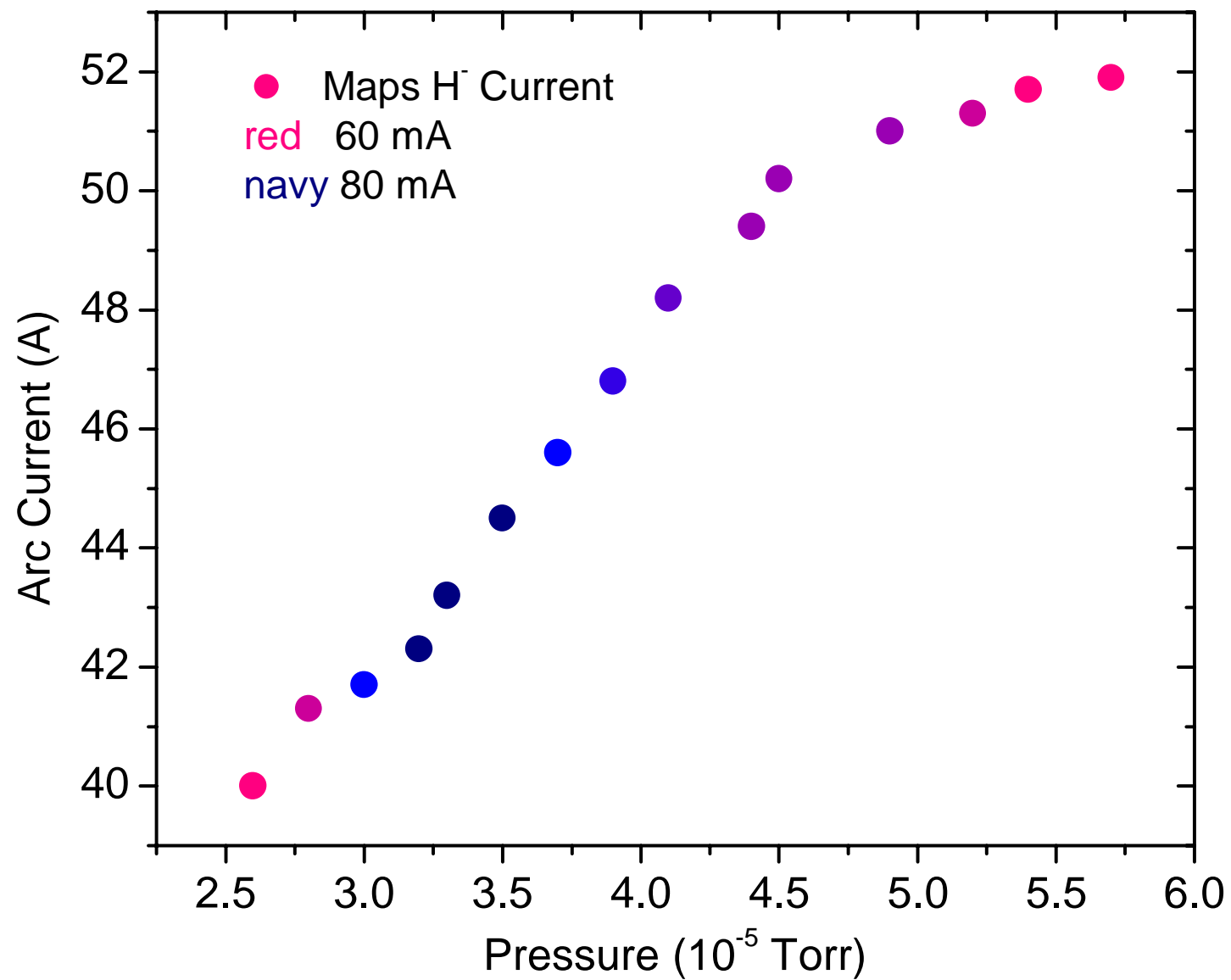$$I_c = I_{ex} \, e^{-(n\sigma l)} \qquad \Delta n = \Delta p \, (n_1/p_1) \qquad \text{From the data}$$

$$I_c(p_1)/I_c(p_2) = e^{-(n\sigma l)\Delta p/p} \qquad\qquad (n\sigma l) = 1.29$$

$$(n\sigma l)\Delta p/p = \ln(I_c(p_1)/I_c(p_2)) \qquad\qquad I_c = 27\% \; I_{ex}$$

We have also observed a possible magnetron configuration with a noiseless discharge.

Unfortunately I did not start recording things on film until after that date. In order to achieve this

Configuration the magnetic field was optimized for the source around 500 G. (check this)

This means utilizing an extraction voltage of only 5 kV producing only about 7 mA. To make this configuration useful

The source magnetic field needs to be better optimized or separated from that of the focusing magnet.

The Magnetron presently puts out 80 ms pulses at 15Hz. Modulation of around 7-10% is regularly observed.

Penning sources are capable of producing are known to have smaller Modulation and lower emittance and may be a good canidate for the future.

This reduction is achieved primaraly through reducing the ion thermal temperature which is around 100 eV in the Magnetron and only 5 eV or so in the Penning Source under the best conditions.